COUNTDOWN ACID RAIN

SUMMARY AND ANALYSIS
OF THE SEVENTH PROGRESS REPORTS (JULY 31, 1989)
BY ONTARIO'S FOUR MAJOR SOURCES OF SULPHUR DIOXIDE

January 1990

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INTRODUCTION

Ontario's Countdown Acid Rain program was formulated in 1985 and placed an annual sulphur dioxide (SO_2) emissions cap of 885 kilotonnes over the province from 1994. In order to meet this emissions limit regulations were passed in December 1985 and require specific reductions in sulphur dioxide (SO_2) emissions at the four companies over a period beginning in 1986 and culminating in a cap totalling 665 kilotonnes, in 1994. The regulations cover each of the four major SO_2 sources in Ontario which together emit over 80% of the SO_2 in the province. In the case of Ontario Hydro, a limit was also placed on the total of SO_2 plus nitric oxide (NO) and interim reductions are required for 1990. In brief, Regulation limits are shown in Table 1.

Table 1
Sulphur Dioxide Emissions
(thousands of tonnes per year)

	1985	1986	1994
Inco nickel/copper smelter, Sudbury	728	685	265
Falconbridge nickel/copper smelter, Sudbury	154	154	100
Algoma iron ore sintering plant, Wawa	285	180	125
Ontario Hydro fossil fuel power plants, province-wide	390	370	175

Semi-annual progress reports are required of the companies. A three year planning and research period was allowed for the formulation of detailed abatement plans, and final reports were received and reviewed.[1]

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[1] Countdown Acid Rain - Government Summary and Analysis of the Sixth and Final Planning Phase Progress Reports Submitted by Ontario's Three Major Emitters of Sulphur Dioxide in the Metallurgical Sector, Ontario Ministry of the Environment, June 1989 and A Review of Ontario Hydro's Acid Gas Report, prepared jointly by the Ministry of the Environment and the Ministry of Energy, June 1989.

Each of the four sources was found to have plans capable of meeting the legislated limits. This document summarizes the contents of the seventh set of the company reports (or the first set in the implementation phase) and the government responses.

THE COMPANIES' REPORTS

All companies report that they are confident that they will stay below the stringent regulated limits and have started implementing sulphur dioxide abatement plans outlined in the final planning phase reports (6th progress reports) of December 1988 (January 1989 for Ontario Hydro) at a rapid pace. By 1994, SO_2 annual emissions limits will be 265 kilotonnes (kt), 100 kt, 125 kt, and 175 kt for Inco, Falconbridge, Algoma and Ontario Hydro, respectively.

Their 7th progress reports have been reviewed by a technical work group drawn from the Ministries of Environment, Northern Development and Mines (for the smelting industries), and Energy (for Ontario Hydro). The government review team found that all four company reports indicate that there are no significant changes with respect to the SO_2 abatement plans outlined in the companies' 6th progress reports. Technical progress continues to be made at three regulated sources, with both Sudbury companies reporting nickel and copper smelting advances. Algoma's iron ore sintering plant at Wawa is planning to meet the regulated SO_2 emissions limit by cutback in sinter production and changes in feed composition as stated in earlier company reports.

However, all four company reports lack the necessary detail for a complete review of their implementation plan in progress. These deficiencies have resulted in several technical and financial issues raised by the government review team.

The following section summarizes individual company reports and outlines the Ontario Government's response to these.

Inco

Regulation 660/85 requires a reduction in SO_2 emission from Inco's nickel/copper smelter complex in Sudbury to 265 kilotonnes by 1994. The regulation immediately limits the 1986 SO_2 emissions to 685 kt and subsequent emissions to 265 kt in 1994. The company was also required to examine the feasibility of reaching 175 kt at some future date. The company's sixth progress report provided detailed plans and schedules as required by the Regulation.

Inco's seventh progress report has been examined by the Technical Support Group of the Countdown Implementation Committee. Some members of the technical group also met with Inco officials and clarified some issues raised in the company's 5th and 6th progress reports. In general, Inco appears to be on track in the implementation of the detailed abatement plan. However, in some areas the company has not provided enough detail, particularly concerning the emission implications of process changes and developments, for adequate assessment to be made.

The Technical Support Group recognizes that Inco is undertaking and refining major and complicated process changes while continuing to operate the smelter. Modifications to the original scope have already been made, and others may follow, to enable the company to meet its primary commitment in an efficient manner. This makes it even more important for the company's progress report to detail the environmental implications of any such changes, so that the government reviewers can be assured that the SO_2 emission limit of 265 kt level will be met by 1994, that reasonable steps are being planned and taken to reduce emissions further from other uncontrolled smelter operating areas, and that fugitive emissions and ground level concentrations will be fully evaluated under the new operating conditions. It is anticipated that information in these areas will be thoroughly discussed in subsequent progress reports.

INCO'S SEVENTH PROGRESS REPORT

Summary	Ontario Government Response
Inco's report indicates that the scope of work for the smelter program to achieve 265 kt/yr SO_2 emission limit has been firmed up significantly since December 1988. So far Inco has committed about $200 million, approximately 40% of the estimated total cost of $494 million for the SO_2 abatement program. Technical development on continuous converting of bulk concentrate matte and MK smelting of copper concentrate is progressing well.	Government review team is pleased with the progress being made in several technical areas of the SO_2 abatement program but is also somewhat concerned that major technical solutions still have to be found by additional developmental work. It is therefore obvious that if Inco fails to resolve these technical problems in a reasonable period, the company may have to resort to appropriate production cutbacks to meet the regulated SO_2 emission limit of 265 kt in 1994.
The report outlines some scope changes in the following areas: (i) use of existing converter for heating and holding copper-nickel-ferrosilicon alloy for washouts instead of 10 MW electric furnace as indicated earlier, and (ii) use of nitrogen to enhance smelting metallurgy in the converter to reduce the number of converters required for bulk-concentrate matte processing.	Inco's proposed change to use a converter instead of an electric furnace for heating and holding (copper-nickel-ferrosilicon) washout alloy in liquid phase is not presented in enough detail to allow assessment of other environmental impacts from this change. The report indicates that use of nitrogen to enhance smelting metallurgy in the converters could increase NO_x emissions from this operation. Subsequent clarification obtained from Inco suggests that NO_x emissions will not increase and the NO_x problem is related only to acid plant operation and acid production.
	Inco should provide details on these changes and all other future changes in appropriate progress reports for the Government review team to properly assess the environmental impacts of these modifications.
	It is important that Inco provide response to outstanding Government concerns raised by the review team to the Company's December, 1988 Final Planning

Phase report (i.e. 6th progress report) and concerns raised for the company's current progress report as soon as possible as outlined below:

- cost implications of fixing matte processing roaster off gases;
- options for making liquid SO_2 if H_2S contamination problem is not satisfactorily resolved.

Future semi-annual progress reports should also include rationale for any scope changes and list accomplishments as per the schedule outlined in the final planning phase report.

Government review team also recommends that along with semi-annual progress reports, representatives of the review team should make periodic visits (once or twice per year) to follow changes being made and to review/discuss any outstanding issues and proprietary details not fully discussed in the company's progress reports.

The company's seventh progress report covers project overview, project scope in brief with some additional information provided on smelter SO_2 abatement and mill rationalization programs.

Specific accounts of relevant developmental work currently in progress at Inco in several SO_2 abatement program areas are briefly mentioned in forthcoming sections with the government review team response. Also an implementation schedule for Inco's smelter development program and mill rationalization program has been attached for ready reference of activities in progress (Appendices 1 and 2).

A) SMELTER DEVELOPMENT PROGRAMS

i) Process Flow Sheets

The company report indicates that major process streams for bulk concentrate operation in transition years and 1994 are defined. However, some gaps still remain due to some issues still under technical development.

The review team is pleased to see that the engineering aspect on the new smelter development program is being firmed up but also notes that some technical issues are still being resolved. The company should include in future progress reports information on solutions with appropriate details when available.

ii) Bulk Concentrate Flash Smelting

Efforts are currently focussed on improvements to flash furnace burner development and controlling fugitive emissions while returning the converter slag to flash furnace.

Very few technical details in this area have been provided and several engineering design problems have yet to be solved.

iii) Matte Converting and Casting

Developmental activities are currently in the areas of adding fine materials to converters without dust problems and reducing cooling time for molds.

This is a good approach since it will improve work room environment and reduce fugitive dust emissions.

iv) Matte Processing

Wet crushing methods to increase matte grinding capacity are being developed to handle higher matte production for bulk smelting as well as to develop acoustic enclosures to reduce noise during milling operations.

Suggested changes, if successful, will provide improved matte processing and reduce noise levels in work areas.

Work is also continuing on scale-up (on defining parameters) for MK copper sulphide flotation columns for efficient copper sulphide separation.

v) Blister Copper Production

MK flash converter reactor design is progressing well and commissioning is planned for mid 1991.

New shrouded tuyere technology being developed will eliminate the need for separate scrap melting and dust processing. Testing of this technology is planned for 1990.

vi) Gas Cleaning

Two alternatives for cooling flash furnace off gases are being evaluated. These are direct quenching by water sprays and vertical cooling shaft. Both these options will be tested in 1989-90 using prototype systems.

This is a key area in the successful implementation of Inco's Smelter SO_2 abatement program and the review team felt that this was not discussed adequately in the report.

Methods of controlling the physical and chemical parameters to eliminate contamination by sulphur, hydrogen sulphide, and nitrogen oxides during scrubbing are also being studied.

Developmental work using a pilot system consisting of Dynaware quench tower and cooling tower for cleaning fluid bed roaster (FBR) off gases has also been tested. More work is needed to remove contaminants to very low levels for meeting product sulphuric acid specifications.

Government review team is pleased to see that Inco is continuing work on cleaning of FBR off-gases. If successful, this has the potential to reduce SO_2 emission below 265 kt/yr by diverting FBR off-gases to acid plant in the future.

vii) Stack and Fugitive Emissions

To counteract the effect of lower gas volume by about 50% and heat content by about 70% in the flue gas, new I.D. fans will be installed to disperse treated smelter off-gases through the 381 m superstack.

The government review team is concerned about the company plans in this area. This is strictly not a problem of the annual SO_2 emission limit under Regulation 660/85, but is of intense interest because of the ground level SO_2 concentration impact on the Sudbury basin. Inco should provide details on expected changes to stack gas

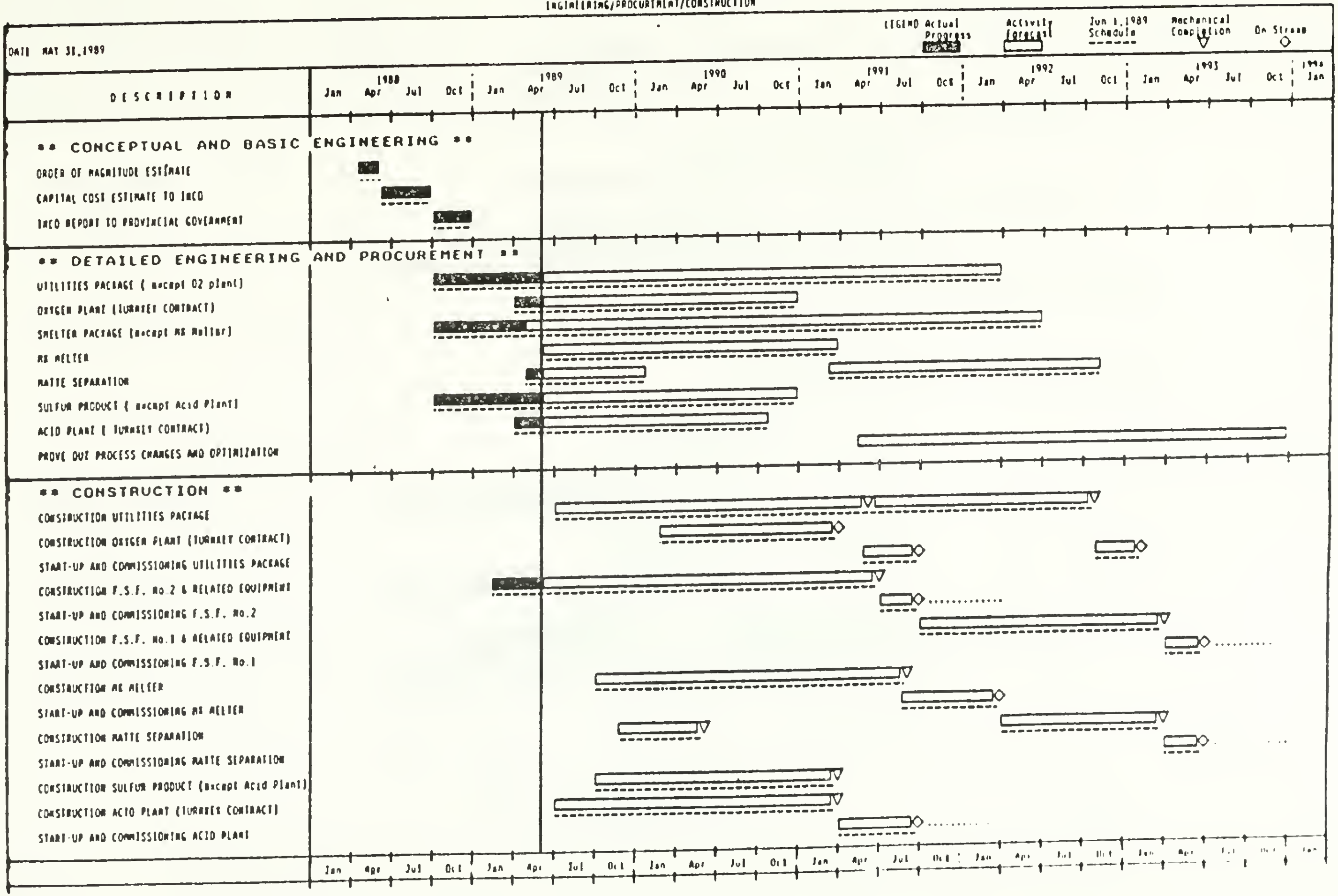
	temperature, velocity, buoyancy etc. when company's consultant has completed the evaluation of the impact of these changes on current ground level concentration (G.L.C.) problems.
Studies are in progress to collect and duct bulk smelting tapping SO_2 emissions to main stack in order to reduce fugitive emissions by up to 75%.	No details are provided by the company at this time to evaluate the benefit of this on ambient air quality in the vicinity of the smelter.

B. MILL RATIONALIZATION

The schedule outlined in the Appendix shows that the project will be completed by the fall of 1990 and optimization will be completed before December 1990. Detailed information is provided on equipment, manpower usage, costs, and project schedules. All engineering work will be completed before December 1989 and approximately 40% of the total $69 million budgeted for this program has been committed.	The government review team is pleased with the progress made in this area by Inco. Details on work completed are given in Appendix 2. It is possible that benefits of this program may show some SO_2 emission reduction before 1994. The Ministry of the Environment is expeditiously processing Certificates of Approval in this area.

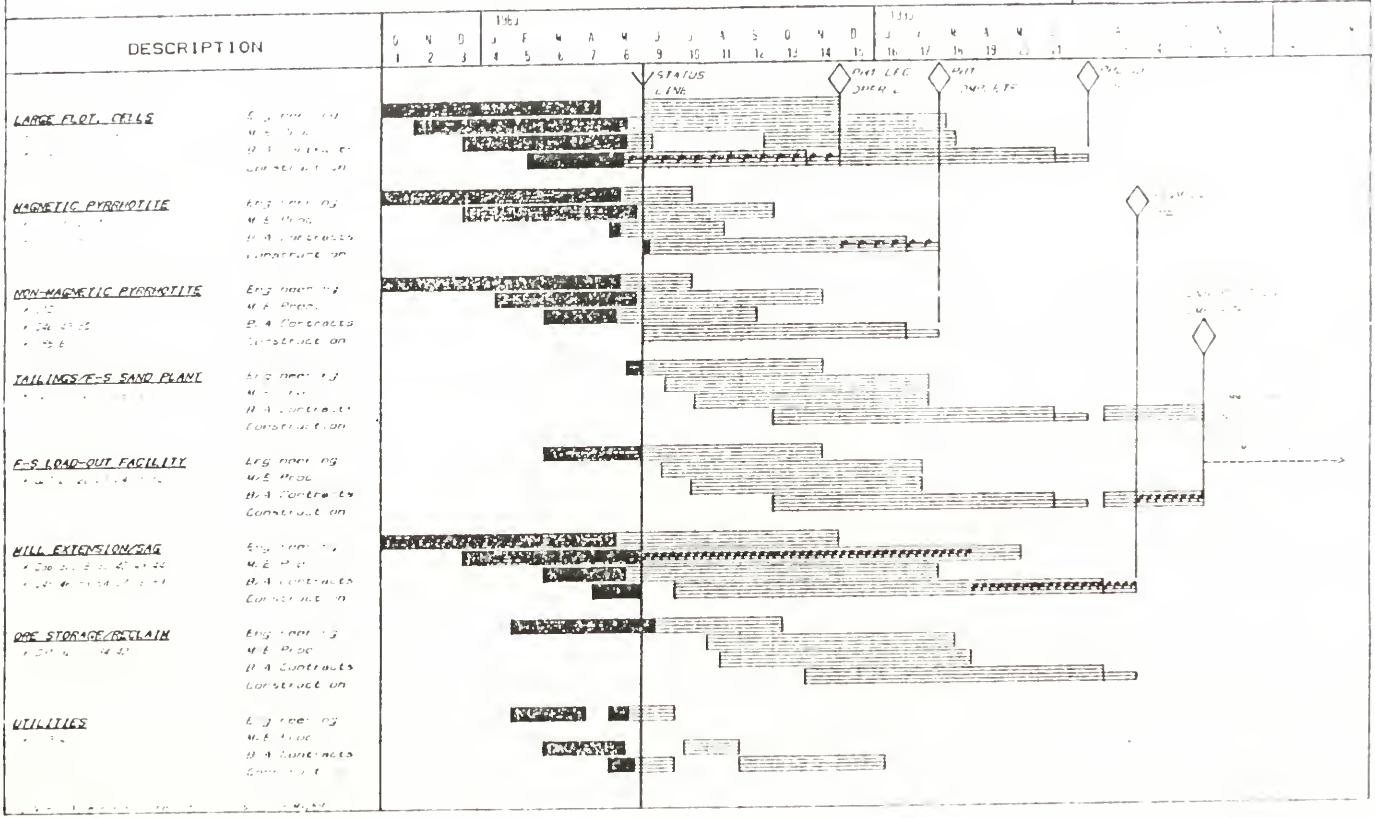
APPENDIX 1

DAVY McKEE CANADA INC.
SO2 ABATEMENT PROGRAM
COPPER CLIFF SMELTER
SUMMARY PROJECT SCHEDULE
ENGINEERING/PROCUREMENT/CONSTRUCTION



APPENDIX 2

INCO LIMITED
MILL RATIONALIZATION
PROJECT SUMMARY SCHEDULE (ACCELERATION)



Falconbridge

Regulation 661/85 requires a reduction in SO_2 emissions from Falconbridge Ltd. nickel/copper smelter in Falconbridge to 100 kilotonnes by 1994. The smelter design capacity is 88 million pounds of nickel per year and, based on technology in place, the SO_2 emissions at the design nickel production are estimated to be 104 kt/yr in 1994.

Regulation 661/85 also requires Falconbridge to submit semi-annual reports on progress in implementing the company's SO_2 abatement program and to evaluate the possibility of reducing SO_2 emissions below 100 kt/yr.

Falconbridge's seventh progress report has been examined by the Technical Working Group of the Countdown Implementation Committee. The company's report indicates no change in plans from the December 1988 report; SO_2 emission limits will be met by making process and equipment changes in the smelter to remove about 65% of the sulphur present in the concentrate during roasting operation as SO_2 which will be captured in the modified roaster acid plant.

This seventh progress report has provided details on capital costs and program implementation schedule for changes to smelter and Strathcona Mill modernization. These schedules indicate that the company plans are progressing well; the Strathcona Mill modernization is expected to be completed by the end of 1991 and the smelter changes will be completed by mid 1993.

The government review team recommends that, due to the tight schedule for smelter process and equipment modifications and continued developmental work and testing, Company and Ministry representatives should meet once or twice per year to discuss concerns arising out of progress reports to avoid unforeseen delays. Also a number of other issues and concerns raised in response to the company's sixth progress report (Final Planning Phase Report) have not been addressed in this report, particularly in the area of operating costs for changes planned, and environmental effects of some of the proposed technical changes. These should be appropriately covered in the next company progress report.

Specific comments by the review team on the company's seventh progress report are addressed below.

FALCONBRIDGE'S SEVENTH PROGRESS REPORT

Summary	Ontario Government Response
A) SMELTER	
i) Roaster	
Company plans to by-pass the secondary cyclones in order to debottleneck roaster off-gas handling system. This will increase dust loading and reduce dust collection efficiency of downstream gas cleaning equipment. However, the report also indicates that this does not seem to have any adverse effects on acid plant.	The review team is concerned with this change as this will significantly increase dust loading on ESPs at 65% sulphur removal and could affect acid quality and arsenic loading to the environment during upset conditions and start-up/shutdown operations. It is therefore important that Falconbridge ensures compliance for arsenic and other trace metals from their modified smelter operations as required by the current Ministry standards and guidelines.
ii) Acid Plant	
Acid plant upgrades planned in 1989 include weak acid cooling, water cooling tower, and mist precipitators areas.	The company has not provided rationale for continued use of a single contact acid plant versus a more efficient double contact acid plant which is considered to be the best available technology in converting SO_2 to sulphuric acid with significantly lower SO_2 emissions.

iii) Stack Emissions

New particulate emission levels resulting from changes in smelter operations will need to be approved as part of the Certificate of Approval and subsequently confirmed through stack tests as per Ministry of the Environment requirements.

B) STRATHCONA MILL MODIFICATIONS

Strathcona Mill changes are progressing well and current research and development work is in the following areas: improving ore grindability and grade, flotation of ore with columns and larger cells to reject more pyrrhotite, and improving process control in mineral processing circuits to ensure desired concentrate-grade for smelting.

The review team is pleased to note that the mill modernization construction program is planned for completion before the end of 1991 and may provide a consistent quality of nickel-copper concentrate for the smelter. This will be followed by an evaluation of new mineral separation techniques to ultimately provide increased pyrrhotite rejection.

No plans are outlined beyond 1991 on the schedule in this report but company's application for Certificate of Approval shows work changes to 1999. This is somewhat inconsistent and an explanation is needed on company's earlier plans to reduce SO_2 emissions to 75 kilotonnes or lower by combination of improved pyrrhotite rejection and increased roasting.

An estimate of breakdown of funds for research and developmental work in this area should also be provided.

Algoma Steel (Wawa)

The Algoma Steel Corporation Ltd. operates an iron sintering plant in Wawa (270 km northwest of Sault Ste Marie). Countdown Acid Rain limits the SO_2 emissions from the operation to 180 kt per year in 1986 through 1993, and to 125 kt in 1994 and thereafter. The previous limit was 285 kt.

As of August 1, 1986, Algoma Ore Division decreased its sinter production capacity at Wawa to about 1.0 million tonnes per year. A reduction of about 50 percent in sinter production coupled with increased use of low sulphur bearing raw materials in the feed has resulted in an SO_2 emission level of 80 kt for 1988.

ALGOMA STEEL (WAWA) SEVENTH PROGRESS REPORT

Summary	Ontario Government Response
The seventh progress report indicates that the company's previous position to meet the 1994 emission requirements remains unchanged. In addition, the company will continue to use low sulphur iron oxides and other sulphur free iron by-products to further reduce the level of sulphur dioxide discharged from the sinter plant.	The reporting requirements of Regulation 663/85 have been met with respect to this progress report.
	Algoma's recent announcement (August, 1989) to the media indicate that the company plans to operate mining operations at Wawa at 50% capacity in 1990. This will be reviewed in 1991 and continued if found economically viable. Changes made to lower sulphur in iron-ore feed to the sintering machine are expected to reduce the overall SO_2 emissions from this facility by about 50% of the current level.
	However, social and economic impacts resulting from these changes have not been evaluated at present and the company officials should formally provide the government with information on the environmental and socio-economic impacts from the recently announced changes for Wawa's iron ore sintering plant operation.

Ontario Hydro

Regulation 281/87 requires Ontario Hydro to reduce its acid gas emissions (sulphur dioxide (SO_2) and nitric oxide (NO)) to 215 kt per year by 1994 and puts a limit on maximum SO_2 emission of 175 kt annually after 1993. In the transitional period, Ontario Hydro has additional limits for total SO_2 and NO emissions:

Period	Regulated Limits (kilotonnes/year)	
	SO_2	SO_2 + NO
1986 to 1989	370	430
1990 to 1993	240	280

Preliminary estimates indicate that Ontario Hydro emitted 381 kt of acid gas (321 kt of SO_2 and 60 kt of NO) in 1988 from its fossil fuel generating stations, which is below the regulated limit of 430 kt for the 1986-1989 period.

To meet the lower limits in 1994, Ontario Hydro plans to commission its first two SO_2 scrubbers at Lambton generating station and has completed the installation of low NO_x burners at Nanticoke. Low NO_x burners will be installed on all units at Lambton generating station by 1994. Conservation and efficiency measures, non-utility generation, hydraulic generation and low sulphur fuel will also be used.

To stay within the legal limits as electricity demand increases, Ontario Hydro calls for another pair of scrubbers to start operation in 1996 at Lambton, another pair in 1997 at Nanticoke followed by another pair at Nanticoke in 1998. Additional hydro-electric power and "clean" generation will also become available.

Ontario Hydro's plan to attain pollution cuts by 1994 and maintain the emission cap will cost an estimated $2.68 billion in current dollars ("dollars-of-the-year") through the year 2000. This will result in increased electricity rates beginning in 1990 and peaking at a 3.4 per cent increase in 1998.

Ontario Hydro is now starting the implementation of the program referred above and their seventh progress report has been reviewed by the Technical Working Group of the Countdown Implementation Committee and the Ministry of Energy. In general, Ontario Hydro appears to be on track in its implementation of the acid gas abatement program. Measures currently taken to reduce acid gas emissions include:

- use of lower sulphur content U.S. coal;
- increased lignite burn at Atikokan and Thunder Bay generating stations;
- continual use of low sulphur coal at Lambton unit #4 with flue gas conditioning;
- reduced electricity exports;
- increased electricity imports.

Specific comments of the government review team are outlined below.

ONTARIO HYDRO'S SEVENTH PROGRESS REPORT

Summary	Ontario Government Response
A. EMISSIONS	
The report indicates that, in the first half of 1989 SO_2 emission totalled 159.3 kt and NO emission totalled 32.4 kt. These data show that Ontario Hydro's acid gas emissions were 6.0 kt lower compared to the same period in 1988.	Although, the review team is pleased to see that Ontario Hydro's acid gas emissions were lower in the first half of 1989, they are concerned over the method used for estimating NO emissions which uses stack tests data on a boiler which has been recently overhauled and does not give typical NO emission factor. This is likely to underestimate NO emission for this type of boiler in service.

Also there is some discrepancy between Ontario Hydro and Environment Canada forecasts on future electricity growth rates for Ontario and this could have impacts on future NO_x emissions from fossil fuel power generating stations.

U.N. Economic Commission for Europe (ECE) protocol for NO_x emission control (agreed last year in Sophia, Bulgaria to which Canada is a signatory) calls for a freeze of NO_x emission at the 1987 level by 1994 and further cutbacks in NO_x emission after 1996.

Ontario Hydro is the largest contributor to NO_x emissions among stationary source(s) in Ontario and contributed about 15% of total provincial NO_x emission in 1985. An increase in Ontario Hydro's NO_x (NO) resulting from future growth will make it more difficult for the Province/Canada to meet the ECE NO_x protocol and to plan for further NO_x (NO) emission reductions under Regulation 281/87.

Ontario Hydro should also take into account the emissions of SO_2 and NO_x resulting from non-utility generation sources (NUGS) in their emission reporting method, as these can be viewed as emissions resulting from increased electricity production for Ontario Hydro.

B. FLUE GAS CONDITIONING

The report indicates that equipment installation will be completed for all units at Nanticoke and Lambton generating stations before the summer of 1990 and that at Lakeview between 1990 and 1994.

The review team is pleased to see that all three major thermal generating stations will be equipped with flue gas conditioning process technology. This action will provide Ontario Hydro some flexibility to meet SO_2 emission limits by using low sulphur western Canadian or U.S. coal in these units in the interim period.

C. ACID GAS ABATEMENT COSTS

The report has provided breakdown of expenditure of $75.2 million in various areas for January to June, 1989. The report also includes revised Table 10.2 from the previous report (6th progress report) which shows estimated costs of acid gas control and electricity price implications based on current dollars ("dollars-of-the-year") for the period 1989 to 2000. The revised estimated costs to year 2000 now total $2.682 billion to stay in compliance with Regulation 281/87 for acid gas emission limits.

The review team noted that the revised Table 10.2 shows an increase of $223 million (approximately 9.1%) in total estimated costs compared to previous figures. Also the current expenditure on acid gas control program weighs heavily on premiums for low sulphur coal use.

The cost information provided in the revised Table 10.2 cannot be easily related to individual station abatement costs and to marginal costs of SO_2 and NO_x reduction at various Ontario Hydro operating stations. This information is needed.

Table 10.2 (revised) provides only limited information on NO_x control. The review team would like to receive additional information on research and development work for NO_x emission reduction referred to in earlier reports and its potential impact on Ontario Hydro's NO_x emission and NO_x control costs.

The review team also would like details on methodologies used to calculate electricity rates reported in Table 10.2 (revised).

D. ENVIRONMENTAL ASSESSMENT STATUS

Ontario Hydro has had its Environmental Assessment for the installation of flue gas desulphurization technologies at Lakeview, Nanticoke and Lambton generating stations accepted and received an approval to proceed. Several conditions have been imposed in the approval. Two important conditions are:

The review team is pleased to see that Ontario Hydro's environmental assessment reports have been found to be acceptable by the concerned parties. It also notes that recent communications between the Ministry and Ontario Hydro indicate that some companies producing gypsum products have shown interest in using Ontario Hydro's FGD wastes for further processing into building materials.

(i) Ontario Hydro will not use low efficiency FGD technologies at base load generating stations, and

(ii) Ontario Hydro will make every possible effort to sell the by-products produced from SO_2 removal technologies.

The review team also notes that this FGD program covers the period up to year 2015 and Ontario Hydro is required to submit to the Ministry, every five years, FGD technology assessment reports covering all new development in this area and Ontario Hydro's plans to meet acid gas emission limits.